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U-PB ZIRCON GEOCHRONOLOGY AND EVOLUTION OF SOME ADIRONDACK META-IGNEOUS ROCKS

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A total of 18 new U-Pb zircon ages from the anorthosite-mangerite-charnockite-granite-alaskite (AMCAL)-suite of the Adirondacks yield the following results (Chiarenzelli et al[1]):

(1) Emplacement ages of the mangeritic and charnockitic rocks are constrained in the interval 1160-1130 Ma;

(2) Hornblende granitic gneiss gives zircon ages of ~1100 Ma but cores of ~1150 Ma have been separated suggesting that 1110 Ma represents a mixed age;

(3) Migmatitic alaskitic gneiss yields ages of ~1070 Ma. Zircons are clear and unzoned in these minimum melt migmatites, suggesting that they grew during anatexis;

(4) Zircons in anorthosites are small, equant, multi-faceted, and clear similar to metamorphic zircons in mafic granulites. These zircons yield ages of ~1050 Ma and are interpreted as metamorphic with Zr exsolved from Fe, Ti-oxides and/or pyroxenes.

(5) Sphene ages in the Adirondack Highlands occur in the interval 1050-950 Ma and this is assumed to be the age of peak granulite facies metamorphism.

These results leave the age of the anorthositic rocks unresolved with the only direct determination being a Nd/Sm age of 1288±36 Ma by Ashwal and Wooden[2]. Based upon apparently mutually cross-cutting relationships, McLelland[3] interpreted the anorthositic and mangeritic/charnockitic rocks as coeval. This conclusion is consistent with the close association of these rock types on a global scale, as well as the repeated zonal envelopment of anorthositic massifs by acidic rocks. That the acidic and mafic rocks constitute a bimodal, non-comagmatic suite has been shown by McLelland and Whitney[4] on the basis of chemical data and field relationships.

The presence of xenocrysts of andesine in charnockite 10-15 km away from the nearest anorthosite indicates that the acidic rocks were largely liquid to at least these distances when they acquired the xenocrysts. Hargraves[5]

and Isachsen et al.[6] have argued that the acidic rocks are older gneisses melted by the intruding anorthosite slab which, upon solidification, was intruded by the still-molten mangerites and charnockites. In order to test this hypothesis the heat flow equation was solved for a 4 km thick sill in a semi-infinite half space with grad. T = 30°C/km. A series of different initial conditions were applied, and it was found that even for the unrealistically extreme case of a totally liquid anorthosite (T=1300°C) intruding into anhydrous granitic gneiss ($T_{INITIAL}$=900°C), melting is limited to ~55% at the contact and decreases quickly to 0% at 4 km above the sill. It is clear that the initial and latent heat reservoirs of the anorthosite are insufficient to produce the magmatic rocks of the AMCAL-suite. In contrast to <u>in situ</u> anatexis by the anorthosite, it is a simple matter for gabbroic magmas ponded at the crust-mantle interface to melt lower crustal rocks. This is because repeated influxes of differentiating mafic magma can supply almost unlimited heat during differentiation towards more feldspathic compositions. Lower crustal anatectites are liable to be high in K_2O since: (1) orthoclase is a near-solidus phase in tonalitic and granodioritic rocks, and (2) anhydrous minima in the Qt-Ab-Or system move away from Qt with increasing P. These K-rich anatectites gather into batches and rise either as discrete plutons or as envelopes of acidic magmas about a core of feldspathic gabbro (leuconorite?) whose plagioclase cumulates will give rise to anorthosites. This is the mode of origin envisaged for the Adirondack AMCAL suite.

The emplacement of the AMCAL suite appears to have taken place under anorogenic conditions but was preceded by a regional metamorphism of garnet-sillimanite-K-feldspar grade and of unknown age. In the southern Adirondacks tonalitic gneiss dated by U-Pb zircon methods are, at least, 1320 Ma old and contain foliated xenoliths of metasediment. Along the St. Lawrence River foliated xenoliths are clearly evident in leucogranitic gneiss of the Rockport pluton dated at 1415±6 Ma by U-Pb zircon methods. Thus the pre-AMCAL suite metamorphism may be older than ~1415 Ma. The chemical signatures of these older meta-igneous rocks are calcalkaline and orogenic. The anorogenic AMCAL suite is evidently bracketed by compressional orogenies.

1.Chiarenzelli, J., McLelland, J., Bickford, M., Isachsen, Y., Whitney, P. (1987) Geol. Soc. Am. Abstracts with Programs 19: in press.

2.Ashwal, L. and Wooden, J. (1983) Geochim. Cosmochim. Acta 47: 1875-1887.

3.McLelland, J. (1987) Geol. Soc. Am. Abstracts with Programs 19: in press.

4.McLelland, J. and Whitney, P. (1987) Geol. Soc. Am. Abstracts with Programs 19: in press.

5.Hargraves, R. (1962) Buddington Volume, Geol. Soc. Am., 163-191.

6.Isachsen, Y., Whitney, P., McLelland, J. (1975) Geol. Soc. Am. Abstracts with Programs 7: 78-79.